

Space Weather Technical Forecast

Issued on Tuesday, 12 July 2022 at 01:36 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Further M-class flares likely with a slight chance of X class flares giving R1 to R3 Radio Blackouts. Chance of G1/Minor Storms mainly late day 1 (12th) into day 2 (13th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with a couple of M flares, the largest being an M1 recorded at GOES16 from AR3056, in the southeast quadrant. A CME was observed off the western limb, around 11/1300 UTC, however its analysis revealed that it's not Earth-directed. No other Earth-directed CMEs were observed in available imagery.

There are seven numbered sunspots on the disc. AR3055 remains largely inactive despite being the largest region. An intermediate spot with penumbra recently emerged, requiring a change of classification. The next largest region is AR3053. This region continues to stretch longitudinally but appears now mature and fairly stable. AR3046, AR3051 and A3052 remain relatively unchanged or are slightly decaying. AR3056 in the SE has been responsible for the recent M flare and has developed a delta configuration in its leading penumbra. AR3057 in the NE is a bipolar region and appears to have the potential to increase its complexity so will be closely monitored for signs of development.

There are currently numerous large filaments on the Sun, with the southern hemisphere in particular harbouring two large features that each span roughly 20 degrees on the solar disc. There were no signs on instability in these in the reporting period, however they will become increasingly relevant should they lift off in the coming few days, and will be monitored.

Solar Wind / Geomagnetic Activity: The expected CME that left the sun on the 08 July possibly arrived at Earth in the UTC afternoon. The solar wind, as observed by DSCOVR at L1, remained slow-ambient but sustained a sudden increase around 11/1620 UTC, its speed rising from 320 to 360km/s. Similarly, the solar wind density rose sharply from 10 to 18ppcc at the same time, and so did the magnetic field strength, rising from 8 to 13nT. The north-south component was negligible initially but became largely negative while stretching down to -12nT for a time. The phi angle was largely positive (away from the sun) with small deviations into the negative sector. The resultant geomagnetic activity was Quiet to Unsettled (Kp 1-3) with a provisional Active interval between 11/1800-2100 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16, is back to background levels and on a decreasing trend, after it became enhanced in the wake of the C8.5 flare that occurred on the 09th.

The high energy electron flux (greater than 2 MeV) remained at Normal Background levels. The corresponding 24-hour integrated electron fluence remained well below the Active ($1e8$ integrated pfu) threshold on a roughly level trend. Observed fluence was $1.64e6$ integrated pfu at 12/0001 UTC.

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Four-Day Space Weather Forecast Summary

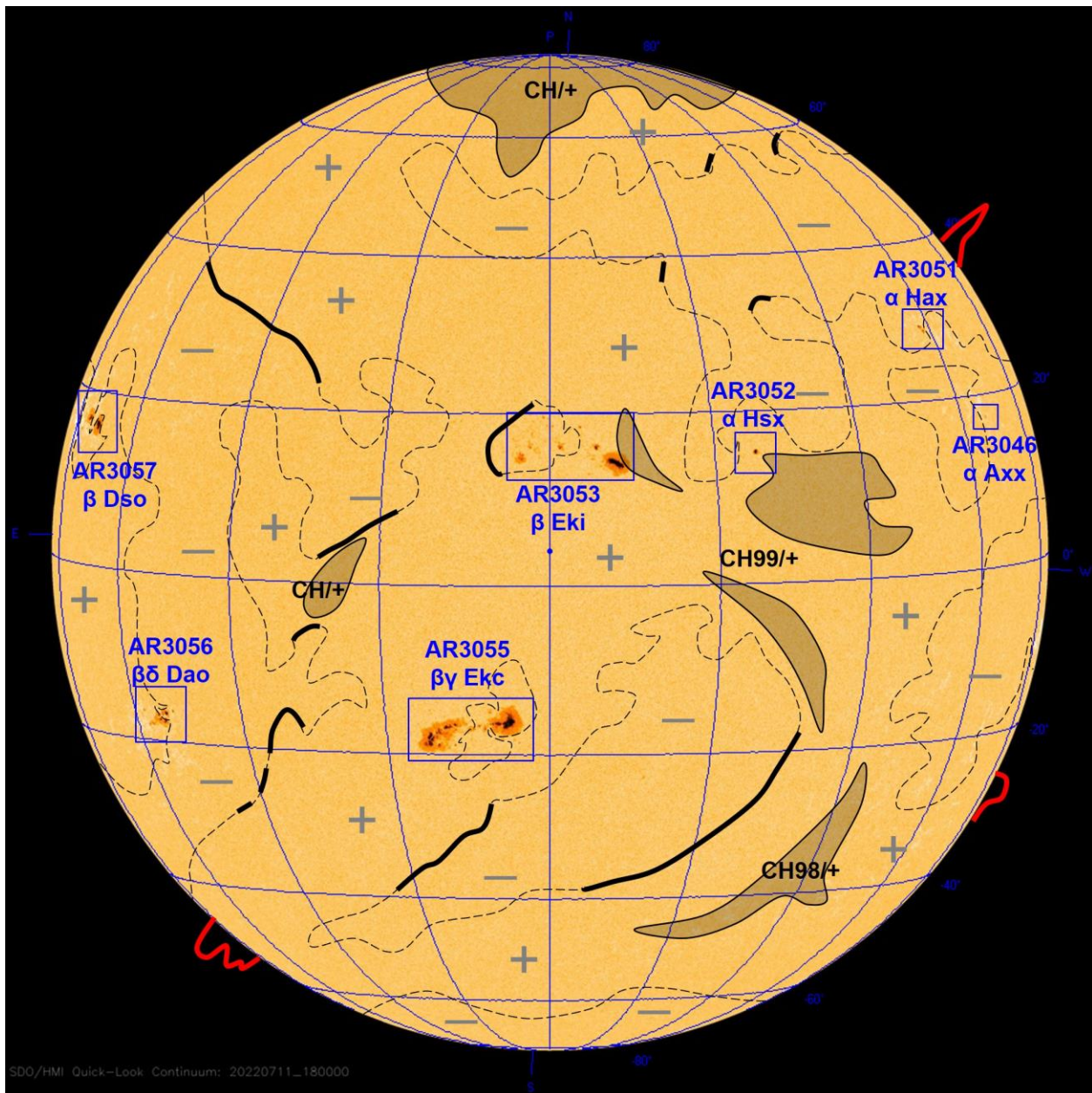
Solar Activity: Solar activity is Likely to be Moderate, with further M-class flares and a Slight Chance of X class flares. There remains a possibility of further sunspot regions emerging over the eastern limb.

Solar Wind / Geomagnetic Activity: A CME may arrive at Earth at the end of day 1 (12th) or early on day 2 (13th). Solar winds are expected to become enhanced under the influence of the HSS from CH99/+, and stay elevated through to day 3, before slowly easing. Overall geomagnetic activity is expected to start Quiet but to become increasingly Unsettled and Active at the end of day 1 and into day 2 (12th and 13th), with a Chance of G1/Minor Storms under the influence of the CME. Geomagnetic activity then returning to mostly Quiet levels on days 3 and 4 (14th & 15th).

Energetic Particles / Solar Radiation: Unless there is significant sunspot development, the high energy proton flux (greater than 10 MeV) is likely to remain at Background levels. There is however a daily Slight Chance of S1 or greater, due to the presence of two relatively large sunspot regions on the centre disc, particularly as they've begun to move across the western hemisphere.

The high energy electron flux (greater than 2MeV) may increase at the end of this period, but the corresponding fluence is expected to remain well below the Active threshold (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 11/2000 UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

Earth may receive a glancing blow from a CME that left the sun on the 09th. While the bulk of the ejecta is expected to miss behind Earth's orbit, a shock is considered likely and its arrival estimated to be late on day 1 (12th) or early on day 2 (13th).

The solar wind is currently at slow-ambient levels but is expected to become soon enhanced, under the influence of the high speed stream originating from CH99/+. It is a recurring feature that generated speeds of 600 km/s on the previous rotation, however, due to its smaller size and fragmentation in the intervening month, it is hard to envisage similar speeds will be achieved this time around. This increase may be superseded by the expected arrival of the CME, perhaps increasing the solar wind to strong levels, but it is generally expected to reach elevated levels on day 2 before slowly decreasing on day 4. CH98/+ may contribute to this enhancement however its input is considered minor, being further away from the Earth ecliptic latitude.

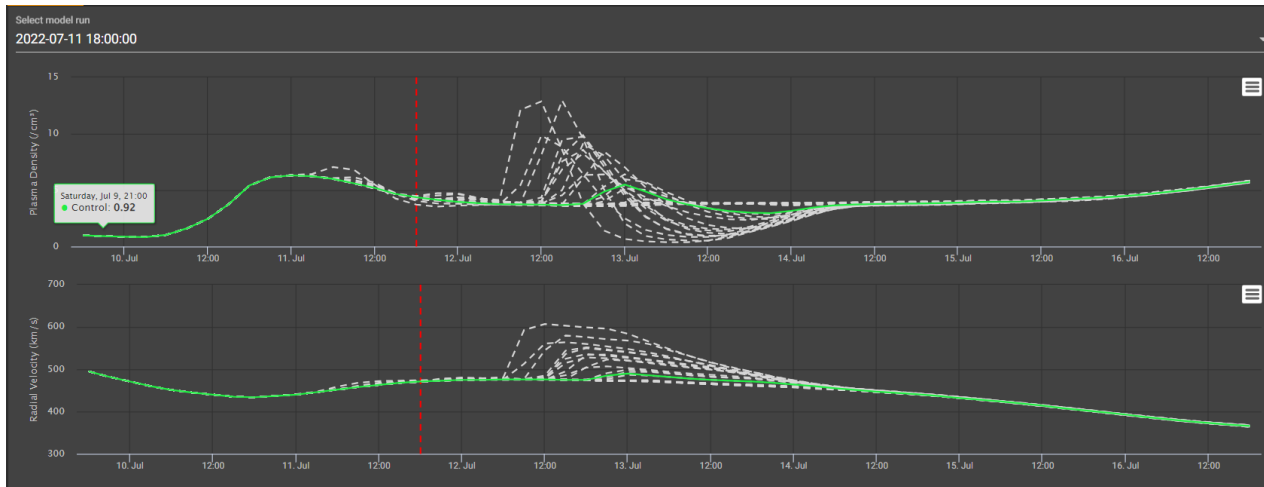
Overall geomagnetic activity is expected to start Quiet but to become increasingly Unsettled and Active at the end of day 1 and into day 2 (12th and 13th), with a Chance of G1/Minor Storms under the influence of the CME. Geomagnetic activity then returning to mostly Quiet levels on days 3 and 4 (14th & 15th).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	30	50	1	1
Strong	G3	No	2	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
10/0500 UTC	Partial halo	AR3052	NE quadrant	918 km/s	12/2200 UTC +/- 6 hrs	Moderate shock

Figure 2: Ensemble showing a large spread, meaning low confidence is terms of timing



Radio Blackouts - X-Ray Flares:

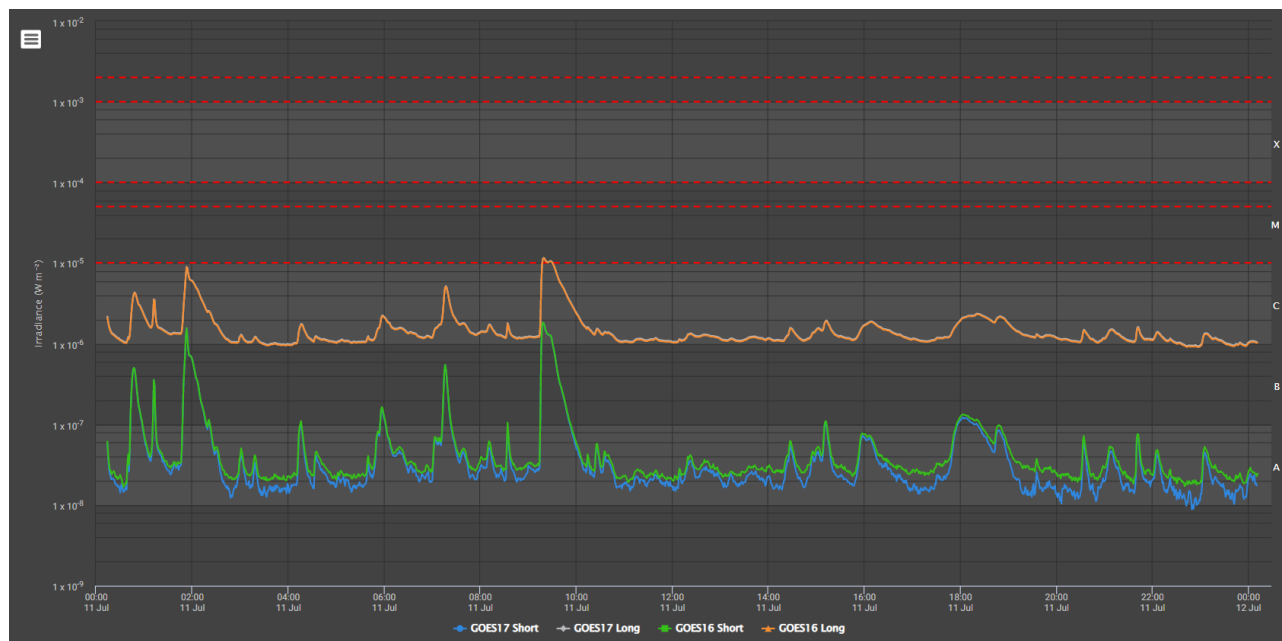
Solar activity has been Moderate with a couple of M flares, the largest being an M1 recorded at GOES16 from AR3056, in the southeast quadrant. Background activity level is now constantly in the C category.

There are seven numbered sunspots on the disc. AR3055 remains largely inactive despite being the largest region. An intermediate spot with penumbra recently emerged, requiring a change of classification. The next largest region is AR3053. This region continues to stretch longitudinally but appears now mature and fairly stable. AR3046, AR3051 and A3052 remain relatively unchanged or are slightly decaying. AR3056 in the SE has been responsible for the recent M flare and has developed a delta configuration in its leading penumbra. 3057 in the NE is a bipolar region and appears to have the potential to increase its complexity so will be closely monitored for signs of development.

Solar activity is Likely to remain Moderate with further M class flares and a Slight Chance of X class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	15	15	15	15

Figure 3: Latest X-ray flare activity, as seen by GOES



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is now back to background levels, after it became slightly elevated on the 09th (in response to a C8 flare). There is however a daily Slight Chance of S1 or greater, due to the presence of two relatively large sunspot regions on the centre disc, particularly as they've begun to move across the western hemisphere.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	10	20	20
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm ⁻² sr ⁻¹ s ⁻¹)						

High Energy Electrons Event ($\geq 2\text{MeV}$):

The high energy electron flux (greater than 2MeV) is currently at Normal Background levels. While CH99/+ is a recurring feature, it is much-changed in comparison with the previous rotation and as such, confidence is relatively low. The expected arrival of the high speed stream and a Slight Chance of a G1 ought to prevent any significant increase in flux levels over the next few days, at least until midweek when a new equilibrium can be achieved.

The corresponding fluence is therefore very unlikely to exceed the Active threshold ($1\text{e}8$ integrated pfu) during this period.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	5	10	10
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 4: Latest REFM output, considered to provide good guidance

